4-04.1 BASIC DESIGN DATA. Basic design data serves as a foundation for the development of plans. Various parts of basic design data are required through the stages of plan development, such as location study report, surveys, preliminary plan development and detailed plan preparation.

4-04.1 (1) TRAFFIC. Functional classification and anticipated traffic are the basic design controls. The interstate system is designed for traffic projected 20 years beyond the P.S.&E. approval date. All systems are designed for traffic projected 20 years beyond the date of construction. Basic design traffic data are included in the location study. Necessary additional traffic data are obtained by the district from the Office of Transportation Management Systems (OTMS) as design proceeds. Also, if the district encounters anything that will change the anticipated traffic during design, the matter is directed to the attention of the OTMS, with the request that the traffic be restudied and revised data be furnished if necessary. An analysis of lane capacity, in accordance with the Highway Capacity Manual, is required for extremely heavy traffic volumes, which is expressed in Directional Design Hour Volume (DDHV). The DDHV is computed as the product of the total ADT (both directions of travel) times the Directional Distribution and the Peak Hour Percentage. The Peak Hour Percentage is estimated between 8% and 15% of the ADT.

4-04.1 (2) DESIGN SPEED. It is desirable to design rural divided roadways with a 110 km/h (70 mph) design speed. Projects which have minimal topographic features which could categorize the roadway as "rolling" or "mountainous" (see Figure 4-04.1) should still use a 110 km/h (70 mph) design speed. Segments of these roadways which contain features which can not satisfy these design criteria should be addressed by the Design Exception Process described in Subsection 2-01.9. The majority of the roadway can still be designed to this design criteria in an economical manner through use of this method. However, where a <u>considerable</u> percentage of the roadway's length is in the "rolling" or "mountainous" category, the roadway should use the corresponding design criteria for the terrain encountered with appropriate design exceptions.

4-04.1 (3) GENERAL DESIGN DATA. Basic design features are tabulated on Figure 4-04.1. Figure 4-04.1 gives all necessary basic design data for facilities up to and including four lanes. Sometimes physical limitations will govern the number of lanes, rather than anticipated traffic. In highly developed urban areas, undivided facilities may be considered because of high right of way costs, and the frequency of intersections. Basic design criteria for urban plans are given in Section 4-07.

4-04.2 PROFILE GRADES AND VERTICAL ALIGNMENT CONTROLS. Vertical alignment design controls are shown in Figure 4-04.1.

4-04.2 (1) GRADES. The profile grade is established in flood plains to keep the shoulders a minimum of 1 ft. [300 mm] above design high water for all systems of roadways. The stream gradient should be considered in establishing profile grades in flood plains. Design high water is normally established by GHQ Bridge.

Maximum rates of grade are shown in Figure 4-04.1. The minimum desirable rate of grade is 0.5% to facilitate handling drainage on curbed sections. The minimum ditch grade specified on plans is 0.3%. It is sometimes necessary to use level profile grades through fills, or as required to match existing improvements.

4-04.2 (2) VERTICAL CURVES. The length of vertical curves should satisfy the requirements of stopping sight distance, comfort, appearance and drainage. Vertical curves at least 300 ft. [90 m] in length are used where practical.

4-04.2 (3) SIGHT DISTANCE. Sight distance is an element of design that affects the safe and efficient operation of a roadway and it is given careful consideration during the location study and preparation of the preliminary plan. Stopping sight distance, based on the design speed, is the sum of the distance for braking reaction and the braking distance required for a driver to stop the vehicle after sighting an object on the roadway. Passing sight distance, based on design speed, is the minimum distance required to safely make a normal passing maneuver on two-lane roadways at passing speeds representative of nearly all drivers. Operational sight distance is a portion of the passing sight distance and is the minimum distance necessary for safe passing at the prevailing speed of traffic (85th percentile speed). Operational sight distance is used by the GHQ Traffic in establishing no passing zones by marking yellow lines on the roadways. Minimum design controls have been established for stopping and passing sight distances. Consideration for the design of a longer vertical curve to provide for operational sight distance is based on good engineering judgment and economy. Horizontal alignment is not generally a consideration for stopping sight distance but can be the critical factor for passing and operational sight distance. Figure 4-04.2 is used as a guide to determine the curve radius (degree of curve) required to obtain sight distance.

4-04.2 (4) STOPPING SIGHT DISTANCE. The design controls for stopping sight distance based on various design speeds are given in Figures 4-04.1 and 4-04.3. These controls are based on a 3.5 ft. [1070 mm] height of eye and a 0.5 ft. [150 mm] height of object. Figure 4-04.4 is used to determine the length of vertical curve required for any stopping sight distance based on the change in grade. The "K" factors given in Figure 4-04.3 are approximate only and are used as a guide in determining the length of vertical curve. The stopping sight distance, as determined by formula, is used as the final control. Where practicable, vertical curves at least 300 ft. [90 m] in length are used.

4-04.2 (5) DECISION SIGHT DISTANCE. Decision sight distance is used where the stopping sight distance is inadequate to allow a reasonably competent driver the distance to react to potentially hazardous situations. This condition may be present in a roadway environment that is visually cluttered, a traffic congested intersection or crossover, or has an unfamiliar roadway geometric configuration. In decision areas the decision sight distance gives a greater margin for error and provides the distance to maneuver a vehicle safely. See Table III-3 in the AASHTO Green Book for decision sight distance values.

4-04.2 (6) PASSING SIGHT DISTANCE. Passing distance is not a design consideration for divided lane facilities. It is usually not practical nor desirable to design crest vertical curves for the passing distances tabulated in Figure 4-04.3 because of the excessive length of vertical curves required. It is also difficult for vehicle operators to know that passing sight distance exists over long vertical curves. To overcome this difficulty, the design controls for passing distance are based on designing grades to provide adequate distance for passing at certain intervals and on a specified percentage of the total improvement. The design controls for passing sight distance, based on various design speeds are given in Figures 4-04.1 and 4-04.3. These controls are based on a 3.5 ft. [1070 mm] height of eye and a 4.25 ft. [1300 mm] height of object. Horizontal alignment is considered in determining the location, extent, and percentage of passing distances. Figure 4-04.5 is used to determine the length of vertical curve required for any passing sight distance based on change in grade.

4-04.2 (7) OPERATIONAL SIGHT DISTANCE. Operational sight distance is not a design consideration for divided lane facilities. Operational sight distance is based on an 85th percentile speed which is the speed at which 85% of the traffic travels at or less and the remaining 15% of the traffic travel is at a greater speed. This speed is generally determined from speed studies made on a roadway after it has been opened to traffic. In accordance with the MUTCD, a 3.5 ft. [1070 mm] height of eye and 3.5 ft. [1070 mm] height of object is used to determine operational sight distance, as shown in Figure 4-04.6.

4-04.2 (8) SAG VERTICAL CURVE CONTROLS. The "K" factors tabulated in Figure 4-04.3 are based on headlight sight distance and are used in the design of sag vertical curves. Where practicable, vertical curves at least 300 ft. [90 m] in length are used.

4-04.2 (9) INTERSECTIONS. Important side roads should intersect the through roadway at a -1% rate of grade from the shoulder of the through roadway, if practicable. When the -1% rate is not practicable, the grade should be designed with good engineering judgment, keeping in mind the difference in grade between the cross slope of the through roadway and the grade of the side road. The side road grade should be such as to discourage accumulation of water at the edge of the through roadway and it should be a relatively flat grade for a distance necessary to provide storage for stopping traffic.

4-04.2 (10) AT BRIDGES. It is preferable to avoid vertical and horizontal curves on bridges. When a horizontal curve is unavoidable on a bridge, spirals and superelevations should not be placed on the bridge itself unless absolutely necessary. Roadway profile grades should be kept as level as possible for a distance of at least 50 ft. [15 m] from bridge ends at locations where the approaching grade is below the bridge elevation and where the bridge is on a level grade. This is to reduce the impact load on the bridge. Flat grades and sag curves can cause drainage problems on bridges over other roads and railroads, and should be avoided. When a bridge is part of a sag curve, the low point on the curve should not be placed on the bridge unless absolutely necessary, also to avoid drainage problems.

Vertical clearances over roadways should conform to Subsection 5-04.4. Reduction of vertical clearances to less than the required minimum must be approved as a design exception by GHQ Design. Upon approval, the project manager should notify the district operations engineer so measurement and posting of the final vertical clearance is coordinated.

4-04.2 (11) RAMPS. Grade controls where a diamond ramp intersects the crossroads are the same as for intersections. Where ramps merge with the through roadway, grades are established by projecting the through roadway profile grade to the edge of the ramp pavement, using crown and controlling cross slopes at sufficient points in the vicinity of the ramp nose to determine a grade for the ramp in this area. Otherwise grade control for ramps are the same as for other roads, based on the ramp design speed. Maximum grade controls are given in Subsection 4-06.8.

4-04.2 (12) OUTER ROADWAYS AND SERVICE ROADS. Vertical alignment design controls for outer roadways and service roads are based on the design speeds and are the same as the controls for other roadways, except that the vertical alignment is modified to the extent necessary to provide adequate service to the adjacent properties. Grades are planned in the vicinity of streams to provide at least the same service in relation to the stream high water that existed prior to the improvement being planned.

4-04.2 (13) PROFILE GRADES ON PLANS. The profile grade information shown on the plans includes rate of grade, each P.I. station and elevation, length of vertical curves, the vertical curve "K" factors, and the stopping sight distance for crest vertical curves. P.I. stations are shown to the nearest 0.01 ft. [0.001 m]. P.I. elevations are shown to the nearest 0.01 ft. [0.005 m]. The length of vertical curve is set in 10 ft. [5.0 m] increments. The "K" factor is shown to the nearest whole number. The stopping sight distance is shown in 5 ft. [1 m] increments. All data for profile grades on outer roadways, service roads, and other roads are shown on plans in the same manner.

For linear grading, a computed profile grade is not shown where Linear Grading, Class 1, is used. Where Linear Grading, Class 2, is used a dashed grade line is shown only where it is necessary to control the grade. This also differentiates the Linear Grading, Class 2, from Volume Grading.

4-04.3 HORIZONTAL ALIGNMENT. Horizontal alignment requirements and considerations are given in the AASHTO Green Book. Figure 4-04.1 summarizes the basic design criteria for horizontal curvature. Horizontal curves are used when tangent lines of the roadway intersect at an angle exceeding ten minutes. (For roadways with less than 400 vehicles per day, curves are not required for intersection angles of 1 or less). The centerline of median is generally used as the survey base line for divided pavement improvements. When the median exceeds 100 ft. [30 m] or is not parallel, consideration should be given to using the inside edge of traveled way of each lane for individual alignment. For undivided pavements, the survey base line is at the center of the pavement. Existing centerlines are used where practicable.

4-04.3 (1) ENGLISH DEFINITIONS. The arc definition of curvature is used for new alignment. The chord definition is used only when an existing curve is utilized in the alignment. Chord definition curves are identified by placing "(chord)" after the radius listed in the curve data on the plans.

4-04.3 (2) METRIC DEFINITIONS. All horizontal curve data will be defined by its radius in lieu of degree of curve. New horizontal curves should be in 5.0 m increments. When an existing curve, either arc or chord definition, is utilized in the new metric alignment it should be soft converted using the U.S. Survey Foot (*U.S. survey foot factor is 0.304800609601219 meters per foot.*).

4-04.3 (3) LENGTH OF CURVE. For small deflection angles, curves should be sufficiently long to avoid the appearance of a kink. Curves should be at least 500 ft. [150 m] in length for a central angle of 5 and increase 100 ft. [30 m] for each 1 decrease in the central angle. For design speeds of 60 mph [100 km/h] or less, the minimum length of a curve should be as follows:

- English - about 15 times the design speed (mph).
- Metric - about 3 times the design speed (km/h).

For design speeds greater than 60 mph [100 km/h], controlled access facilities that use flat curvature, a desirable length of curve should be as follows:

- English - about 30 times the design speed (mph).
- Metric - about 6 times the design speed (km/h).

4-04.3 (4) SUPERELEVATION AND WIDENING. Superelevation rate, widening, and length of transition for various design categories are given on Standard Plans 203.20 and 203.21. For divided pavements with narrow medians of 16 ft. [4.8 m] or less in width, the superelevation runoff length for undivided roadways should be used. For multiple lane roadways, the superelevation runoff length is multiplied by the appropriate factor based on the number of lanes. In urban areas where roadways with more than four lanes intersect at grade, consideration should be given to reducing the pavement cross slope to minimize the difference in elevation between the extreme edges of the traveled ways. The difference in the rate of cross slopes for adjacent lanes should not exceed 5%, or 0.05 ft./ft. [0.05 m/m]. When the plans utilize the data given on the standard plans, only the maximum rate of superelevation and the maximum widening are shown with the horizontal curve data on the plans. Complete details of the superelevation and widening transition must be given on the plans if the standard plans details are not used.

4-04.3 (5) SPIRAL TRANSITION CURVES. Spiral curves are used on all roadways that have a design traffic greater than 400 vehicles per day, design speed greater than 50 mph [80 km/h] and a degree of curve greater than 2 [curve radius that is less than 875.0 meters]. The length of spiral is the same as the length of superelevation and widening transition given in the standard plans.

4-04.3 (6) SIGHT DISTANCE. Figure 4-04.2 shows a graph and the equation used for determining the curve radius (degree of curve) required to provide the necessary horizontal sight distance for stopping and/or passing.

4-04.3 (7) CURVE DATA ON PLANS. Section 4-10 has examples of the curve data required to be shown on the plans.

4-04.3 (8) STATIONING FOR MAIN ROADWAY. Stationing proceeds from north to south or from west to east.

4-04.3 (8) (a) ENGLISH. If the project is an improvement of an existing route, the stationing of the existing route is used. The ends of the proposed improvement are tied to the existing route when applicable.

4-04.3 (8) (b) METRIC. If the project is an improvement of an existing route, the existing plans should be used to calculate the correct distance in kilometer stations for the beginning and ending of projects. *When converting existing English stationing to kilometer stationing use the U.S. survey foot factor of 0.304800609601219 meters per foot.* Equations may be required to correct minor differences and alignment relocations. The ends of the proposed improvement are tied to the existing route when applicable.

4-04.3 (9) STATIONING FOR CROSSROADS. Stationing of intersected roadways is based on the existing stationing, if it exists.

4-04.3 (9) (a) ENGLISH. For crossroads where there is no existing stationing, the stationing proceeds from the left side of the intersection to the right side. The stationing is chosen such that a five station increment occurs at the intersection with the main roadway.

4-04.3 (9) (b) METRIC. If stationing exists, then the English stations will be used to calculate the corresponding kilometer station at the point of intersection. *When converting existing English stationing to kilometer stationing use the U.S. survey foot factor of 0.304800609601219 meters per foot.* For crossroads where there is no existing stationing, the stationing proceeds from the left side of the intersection to the right side. The stationing is chosen such that a 0.2 kilometer station increment occurs at the intersection with the main roadway.

A sufficient distance is allowed on the left side of the interchange to provide the proposed improvement without having to use negative stationing. The crossroad stationing is equated to the main roadway stationing at the point of intersection and the angle of intersection is indicated.

4-04.3 (10) RAMP BASE LINES AND STATIONING. The base line for a ramp is located along the right edge of the traveled way relative to the direction of traffic. The stationing is carried in the direction of traffic except for diamond interchange ramps. Diamond interchange ramps are stationed in the same direction as the main roadway stationing. Ramp base lines are equated to the main roadway or cross road at their termini.

4-04.4 CUT AND FILL SLOPES. The recommended cut and fill slopes are contained in the soil survey report as discussed in Section 6-01.

4-04.5 MEDIANS. Medians provide a separation area between opposing lanes of traffic. The median area can provide protection and control of cross and turning traffic or refuge for pedestrians. The use of lighting and placement of signals relating to medians and divisional islands is given in Sections 8-01 and 8-02. Median width transitions and tapers are designed to at least the lengths required for auxiliary lanes as given in the AASHTO Green Book, Tables X-4 and X-6.

Four general types of medians are used: depressed, barrier, raised curbed, and flush. The type of median for a particular route or project is generally selected at the location study report stage based upon the criteria shown on Figure 4-04.7, which shows the warrants for median treatment.

4-04.5 (1) DEPRESSED MEDIAN. A minimum width for depressed median is 60 ft. [18 m]. Depressed medians are preferred for all rural areas. Typical section D-61 shows details of a 60 ft. [18 m] depressed median.

4-04.5 (2) MEDIAN BARRIER. The three types of median barrier used by MoDOT include concrete barrier, Type B guardrail, and three-strand guard cable. Concrete barrier and Type B guardrail are placed on a flush median. Figure 4-04.7 is used to determine the locations for which these two types of barrier are to be provided. Type B guardrail should be used in those locations in which a median barrier is to be provided but site conditions will not permit the use of a concrete barrier (drainage, visibility requirements, aesthetics, etc.). The concrete barrier is generally limited to the high volume roadways with narrow width medians. An approved crash cushion or sloped end crashworthy end terminal is the required end treatment for concrete barriers. A barrier height transition should not be used in locations where the posted speed limit is greater than 35 mph. Where height transitions are used, they should be located as far as practicable from the traffic lanes, and if possible, the lead end flared outside the clear zone. Concrete barrier details and barrier height transitions are shown in Standard Plan 617.00. The distance between the left hand edge of the lane next to the median and the face of the concrete median barrier should be not more than 15 ft. [4.5 m] maximum.

Many existing freeways have medians which are more than 36 ft. [10.8 m] in width. These medians are of sufficient width to satisfy clear zone requirements, thus making the provision of median barrier (see Figure 4-04.7) optional. While the provision of a concrete barrier or Type B guardrail may not be required at these locations, a three-strand guard cable may be desirable.

A three-strand guard cable barrier should be considered for median applications on freeways where cross median accidents are occurring. Guard cable used at any location other than in the freeway median will require approval through the design exception process (see Subsection 2-01.9).

For medians which are more than 36 ft. [10.8m] in width (as measured from inside edge of travelway to inside edge of travelway) the installation of three-strand guard cable as a median barrier on freeways should be considered when one or more of the following conditions exist:

- On horizontal curves with radius less than 2000 ft. [600 m]
- On "stepped" medians (opposing directions of traffic are at different elevations and median slopes exceed 6:1)
- Accident history (in particular, areas with a cross median accident rate exceeding 0.8 per 100 million vehicle miles)
- In the vicinity of traffic conflict points including interchange ramps
- Rapidly increasing volumes of traffic
- In areas where the level of service of the freeway is "D" or less

The designer should evaluate the need to provide three-strand guard cable in these situations and document the results of the evaluation.

Figure 4-04.7 (Sheet 3) presents three basic median sections for which placement of three-strand guard cable is identified; a depressed "Standard" median with a ditch section, a stepped median with significant differences in elevation, and a raised median with a median berm.

In all situations, the slopes and the ditch section should first be checked to determine if the guidelines previously stated suggest installation of a cable barrier.

- If both slopes are equal to or flatter than 6:1 (Illustration 1 Figure 4-04.7, Sheet 3 of 5) a barrier should be placed at the center of the median
- If an embankment slope is steeper than 6:1 (Illustration 2 Figure 4-04.7, Sheet 3 of 5) a barrier should be placed on the 6:1 or flatter slope at least 14 feet from the shoulder point of the opposing lanes of travel
- Placement criteria for barriers in raised medians, or median berms (Illustration 3 Figure 4-04.7, Sheet 3 of 5) have not been clearly defined. Research has shown that a cross section of sufficient height can redirect vehicles impacting it at relatively shallow angles. As a general rule, if the cross section itself is not adequate to redirect errant vehicles (i.e. the slopes are relatively flat), a three-strand guard cable barrier should be placed at the apex of the cross section

In situations where median slopes are steeper than 6:1 the median should be reshaped, if at all possible, to attain cross slopes that are 6:1 or flatter. If utilities are present in the center of the median, the guard cable alignment may be offset as much as 3 ft (1 m).

It is important to remember that to be effective, a cable barrier must be mounted on a moderate slope (6:1 or flatter). The approach to the cable barrier from the traveled way should also be without a curb or a ditch. For specific installation guidelines please refer to Standard Plan 606.41.

Following installation of three-strand guard cable or access control cable, mowing vegetation beneath and immediately adjacent to the cable is not practicable except by hand trimming methods. Typically the area under the cable will be sprayed with herbicide to kill vegetation and minimize hand trimming requirements. Placement of aggregate bedding material as a rock ditch liner 4 in. (100mm) deep and 4 ft (1.2m) wide and a vegetative barrier beneath guard cable or access restraint cable during installation is recommended to minimize washout of the median due to lack of vegetation. See Standard Plan 606.41 for details of aggregate bedding material used as ditch liner beneath cable.

Although the cable system is relatively inexpensive to install, when compared with a concrete barrier or Type B guardrail system, and performs well when hit, it must be repaired after each hit to maintain its effectiveness. This repair must be done as quickly as possible after a hit to ensure the effectiveness of the barrier. Consequently, it's use in areas where it is likely to be frequently hit is not recommended. In these situations other types of median barrier should be considered.

4-04.5 **(3)** **RAISED CURBED MEDIANS.** Raised curbed medians provide curbs 6 to 8 in. [150 to 200 mm] in height, and may be integral, or curb and gutter. Mountable curbs are usually used except where protected left turn lanes are provided or where a vertical curb face should be specified. Where vertical curb face is used, the curb is offset from the edge of the traffic lane by at least 1 ft. [300 mm] for continuous medians and at least 2 ft. [600 mm] for islands and short median sections. Raised curbed medians are used where depressed medians cannot be provided and on roads other than freeways with volumes of traffic under 20,000 ADT. Continuous raised medians 10 ft. [3 m] or less in width are usually paved and those wider than 10 ft. [3 m] are usually sodded. Short raised medians are paved. With concrete paved traffic lanes or curb and gutter, the raised median is paved with asphaltic concrete or portland cement concrete. Where the traffic lanes are asphaltic concrete the raised median is paved with asphaltic concrete. Plans show details for doweling of concrete median strip to previously constructed pavement. Details of the face of curb on concrete median strip are the same as shown on standard plans. The concrete area of irregular shaped medians is computed by the square yard [square meter]. In medians of uniform width, it is computed by the linear foot [meter]. The same unit of measurement for median quantities should be used on a project to reduce the number of bid items. Payment for constructed median is made under the item concrete median or concrete median strip. Medians using asphaltic concrete are paid for by the ton [megagram] of required asphaltic concrete material.

4-04.5 (4) PAINTED FLUSH MEDIANS. Painted flush medians are provided on all multi-lane roadways when median widths are 4 ft. [1.2 m] or less. A minimum median width of 4 ft. [1.2 m] should be used where feasible. Painted median lines consist of two solid yellow lines in each direction.

4-04.6 OUTER ROADWAYS AND SERVICE ROADS. Outer roadways and service roads are specified where required to provide access to adjacent property and to minimize the number of access points connecting to the main roadway. Where the right of way is acquired with full control of access, outer roadways and service roads are used exclusively to provide access to adjacent property. For projects where construction will be staged and the ultimate facility will not be completed for a number of years, careful consideration should be given to providing temporary access for the initial project. Both initial and future access is shown on the plans, with close liaison of personnel from the district Right of Way and Chief Counsel Office staff. Where the right of way is acquired with limited access, and in some cases without access control, such roadways are used to minimize the number of access points, or provide maximum safety of the access point. These roadways are located and planned to blend with the main roadway in such manner that they are an integral part of the completed facility, and as required to present a good appearance.

4-04.6 (1) DEFINITIONS. Service roads and outer roadways are designated roadways by the following definitions:

- Roads to be designated "Outer Roadways" on the plans must (1) provide direct access to the freeway or expressway by means of an interchange or at-grade intersection, (2) be constructed fully within the limited access right of way of the freeway or expressway, and (3) must be maintained by the state. The inside shoulder of all outer roadways must be marked with the "No Right of Access" symbol.
- Roads to be designated "Service Roads" on the plans (1) do not necessarily provide direct access to the freeway or expressway but do provide access to other established road systems, (2) may be located wholly or partially within the limited access right of way of the freeway or expressway, (3) must be maintained by the state where located within the limited access right of way and may be maintained by the state where located or constructed on non-limited access right of way. The inside shoulder of service roads located within limited access right of way must be marked with the "No Right of Access" symbol.
- Roadways not meeting the criteria described above for outer roadways or service roads must be constructed on right of way outside the limits of the normal limited access right of way and must be maintained by the local political subdivision. These roadways should be designated by a term descriptive of their function, i.e., relocated local road, relocated city street, county road extension, etc.

4-04.6 (2) PROCEDURE. The proper procedure is to determine, at the preliminary plan stage, the ownership of outer roadways, service roads and relocated local roads necessitated by the construction of the freeway or expressway. Municipal and county agreements may be needed, as detailed in Subsection 1-03.7. Each roadway should then be properly designated on the design plans with respect to its function and the right of way established consistent with the policy.

When it is necessary to revise or adjust a local road or street, county or city officials should be contacted at the preliminary plan stage to discuss the proposed changes to their system. Right of way is to be taken for these adjustments and connections to the local roads. After completion of construction, the deeds for the local right of way should be forwarded to the agency involved with plans and/or sketches showing the affected roads or streets.

4-04.6 (3) SEPARATION STRUCTURES. For grade separations, where the separation structure involves a local road (county road or city street), the state will be responsible for maintenance of the structure only. The maintenance of the local road, whether over or under the main roadway structure will be the responsibility of the local political subdivision. An understanding or agreement to satisfy this requirement should be addressed during the contact with the county or city officials.

4-04.6 (4) EXAMPLES. Figure 4-04.8 is an example consisting of situation sketches and instructional or explanatory narratives for each situation. All sketches are diagrammatic and should not be construed as suggesting geometric details.

4-04.6 (5) JUSTIFICATION. Consideration is given to safety, convenience, and economy in deciding where outer roadways or service roads will be specified. Consideration of these roadways is justified on roads with limited access right of way where the number of access points can be appreciably reduced. Consideration of outer roadways or service roads is justified where the construction of short sections of such roadways will considerably reduce travel distance, and where right of way costs can be reduced by more than the initial construction cost plus the cost of maintaining such roadways. This cost comparison is used in the justification of outer roadways and service roads. Safety factors such as reducing the number of access points and determining the location of access points require the exercise of good engineering judgment. The extent of outer roadways and service roads is held to a minimum and is consistent with the type of improvement. The use of existing roads should always be considered. If necessary, existing roads can be improved for use as outer roadways or service roads. Sometimes existing roads can be improved or new roads constructed some distance from the roadway improvement and the ownership transferred to the local authority. On the interstate system, interstate funds can be obtained for construction on existing roadways which are to become outer roadways or service roads, if the construction is necessary to provide an adequate facility for the traffic projected 20 years beyond the P.S.&E. approval date. In this case each section of such roadway is treated individually, and approval for reconstruction of such roadways is obtained at the preliminary plan stage.

4-04.6 (6) TRAFFIC. Along with other factors, outer roadway and service road designs are based on traffic volumes projected 20 years beyond the date of construction, except that these designs on the interstate system are based on traffic volumes projected 20 years beyond the P.S.&E. approval date. The district requests traffic data from OTMS. Such requests are accompanied by sufficient maps and information to provide OTMS with complete information for their use in analyzing, assigning, and forecasting traffic. The district also furnishes OTMS with any information that they may have that will affect traffic volumes, such as proposed industrial areas, subdivisions, etc.

4-04.6 (7) DESIGN STANDARDS

4-04.6 (7) (a) RURAL AND SUBURBAN AREAS. Forecasted traffic volumes (design traffic) are used with the functional classification for establishing the design criteria for general roadway improvements. Other factors enter into the design of outer roadways and service roads which are of greater importance than the design traffic. Some of these factors are:

- the land area served by the outer roadway or service road that is to be built.
- the type of road that such roadway replaces.
- existing or anticipated land development of the area to be served by the roadway.
- the maintenance convenience.

These roadways are designed with surface types at least as high as the surface type of the existing roads and streets in the area generally served by the outer roadway or service road. Quite often such roadways are constructed to replace the service provided by an existing road. In such cases the roadway is designed to at least the equivalent standards of the existing road. The equivalent standard is defined as the standard required to replace the service and utility of the existing road, based on the traffic which will use the outer roadway or service road, after the improvement is completed. An exception is that if the existing road has a dustless surface it is usually replaced with a dustless surface. Traffic data should account for existing improvements and developments. Sometimes outer roadways and service roads are designed with the same surface type as used for adjoining sections of outer roadways or service roads or existing roads or streets connecting to the outer roadway or service road for maintenance continuity and convenience where such surface types are higher than that which would be normally used for such roadway. After considering these factors, the design traffic is considered and the design criteria is based on the highest requirements based on all factors considered. Outer roadways and service roads are designed to full standards in the initial stage for at least that portion falling within the limited access right of way of the main road. Outer roadway and service road surface types and their selection are given in Section 6-03. Standard typical sections based on the criteria on which the outer roadway or service road is being designed are used. Foreslopes, backslopes, and fillslopes used on the main roadway should also be used on the outer roadway and service road. Where rural and suburban outer roadway and service road designs are based on design speeds greater than 50 mph [80 km/h], typical roadway sections with clear zones are considered. Where such roadway designs are based on design speeds of 50 mph [80 km/h] or less, the clear zones are omitted unless a state route is carried along the outer roadway or service road in which case the clear zones are retained in accordance with the design traffic requirements. In the preliminary design of outer roadways and service roads, the controlling grades and curvatures applicable to other state roads are used as tabulated in the Figure 4-04.1. An exception is that sharper curves may be used at the termini in the vicinity of interchanges. After the preliminary design has been selected, the outer roadways and service roads are reviewed and necessary modifications to the grades and curvatures are made to ensure that such roadways adequately serve the adjacent properties. Modification in the grades and curvatures necessary to serve the adjacent properties are not considered substandard.

4-04.6 (7) (b) URBAN AREAS. Outer roadways and service roads in urban areas are designed to the same standards and criteria as such roadways in rural and suburban areas if conditions and restrictions permit. An exception is that a design speed of more than 40 mph [70 km/h] is not usually used. Outer roadways and service roads which serve and areas subject to industrial, commercial or residential development are designed to meet the requirements necessary to properly serve the area after the improvements are realized. In these cases the highest possible standards are used which will provide service to the adjacent properties. Other factors for outer roadways in urban areas are given in Section 4-07.

4-04.6 (8) LOCATION. Outer roadways and service roads are located in such manner that they will blend with the main roadway and become an integral part of the completed facility. These roadways are usually located so that independent drainage structures can be constructed, and so that guardrail is not required where the main roadway is in a cut section (See Section 4-09). Outer roadways and service roads are planned and located in the vicinity of railroads in such manner that additional railroad grade crossings are not created, if practicable. It is usually best to locate such roadways at a constant distance from the main roadway without angular breaks, and with a minimum number of curves. This is accomplished by establishing maximum offsets as control points, and offsetting the roadway at a reasonably constant distance required by these controls. See Section 4-06 for details of intersections of outer roadways and service roads at interchanges.

4-04.6 (9) GRADING. Grading for outer roadways and service roads is coordinated with the main roadway grading to improve appearance. Double ditches between these roadways and the main roadway in fills are avoided. Linear grading may be used to construct outer roadways or service roads where the grading is within the controls given in Section 4-08. Volume grading is generally used where the controls are exceeded or where compaction is required. Outer roadway and service road grading quantities are usually indicated on the plans separate from other grading quantities. The outer roadway and service road grading is kept independent of the main roadway grading if practicable.

4-04.6 (10) CONSTRUCTION SEQUENCE. Sometimes it is necessary that the outer roadways or service roads be constructed before the main roadway, to handle traffic while the main roadway is being constructed. Also, higher standards for outer roadways and service roads may be justified if the roadway can be used for bypasses, thereby realizing a better completed facility. Otherwise these roadways should be kept as independent of the main roadway as practicable. These items are carefully considered and decided upon prior to proceeding with the design.

4-04.6 (11) PLANS. Outer roadway and service road profiles and grades are plotted on either the main roadway plan-profile sheet or on a separate full profile sheet. When the main roadway plan-profile sheet is used, the outer roadway or service road profile and grade is plotted on the same datum used for the main roadway profile and grade, and the two are differentiated by using a different legend for the outer roadway and service road. When full profile sheets are used, they carry a sheet number subsequent to the main roadway plan sheet number on which the outer roadway or service road appears. Outer roadway and service road limits are shown on preliminary plans insofar as their location is known at the time the preliminary plan is prepared. Preliminary plan approval will constitute approval of the roadway locations shown. The plans show complete details for outer roadways and service roads including alignment grades, typical sections, etc. Roadway alignment for these roadways include ties to the main roadway survey centerline at all angle points and complete curve data for all curves. Outer roadways are identified on the plans with the note "Outer Roadway". Service roads are identified on the plans with the note "Service Road". The note also includes a description of the roadway such as "9.0 m Outer Roadway, Gran. Surf.," etc.